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THE BICHROMATE PLUNGE BATTERY.

Robert Gibson Griswold.

As a source of electrical energy for experimental purposes the battery composed of several Voltaic cells presents to the amateur the simplest generator extant. They require little attention, are always ready when needed, and the cost of renewal of such parts as engage in the chemical reactions within the cell is comparatively low. Compared to the dynamo as a source of power for general purposes it is very expensive and for this reason has precluded every attempt in such directions to successfully substitute it for power driven generators. There are many small dynamos in the market but they require some form of power to drive them which is not always available.

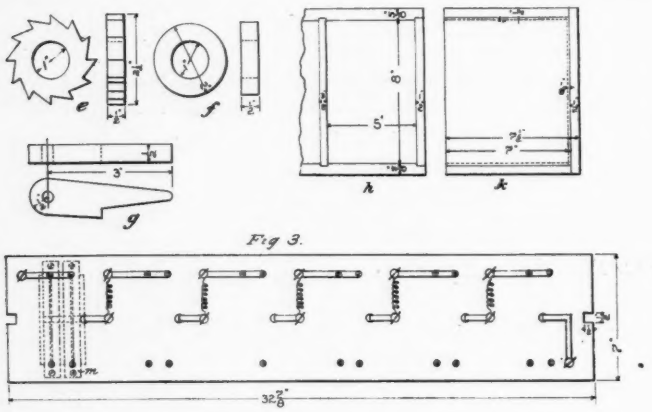
Of the many forms and types of batteries in existence, one principle alone, that of chemical action between the cell elements and the electrolyte, governs their design, with the exception of the thermal types. The generation of a current by any cell of this description, is invariably accompanied by a chemical action within the cell, and in fact, the production of a current depends entirely upon this chemical action. One of the elements must be of such a nature that it can readily enter into a chemical union with certain parts of the electrolyte or exciting fluid. This union will generate a certain electromotive force and if a closed circuit is formed outside the cell a current will flow.

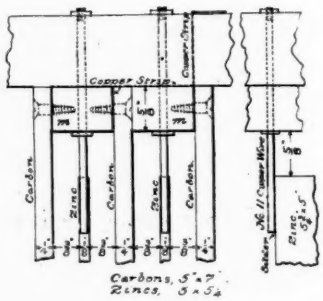
In the type about to be described the elements are zinc and carbon plates, and the electrolyte a solution of sulphuric acid and bichromate of potassium in water. The zinc enters into a combination with the sulphuric acid, forming zinc sulphate and free hydrogen; the latter element would collect on the carbon plate and polarize the cell owing to the high resistance of a gas, were it not for the potassium bichromate which is added to the solution as a depolarizer. This salt contains a large proportion of oxygen and the nascent hydrogen is consumed as fast as liberated, forming water and chrome alum. This depolarizing action permits the cell to be used on a closed circuit through which it will deliver a very constant current. Cells not provided with a depolarizer soon have their internal resistance raised to such a high degree that only a very small current can flow. The carbon element takes no part in these chemical reactions, but merely serves as a collector for the current generated in the cell.

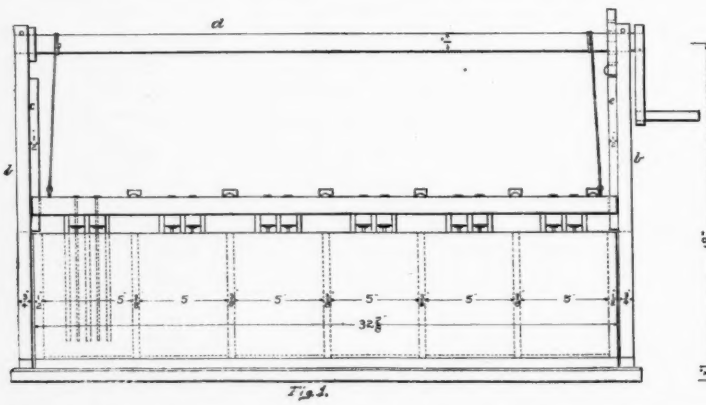
The form of battery about to be desesibed is most admirably adapted to the needs of the experimenter, as the two parts that need renewing are comparatively cheap and easily obtained. The volume of current is easily regulated within certain limits. All local action, or wasting, during the inactive periods of the cell is prevented by lifting the elements from the electrolyte. The E. M. F. of each cell being about 2.1 volts, that of the entire battery, with all cells in series, is about 12.6 volts and since the internal resistance is low, a very large volume of current will be delivered, especially when freshly charged, falling of gradually as the electrolyte becomes exhausted.

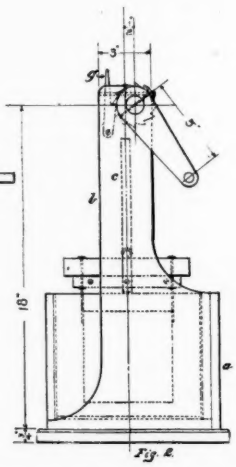
The framework, including the windlass supports, is made of pine, all joints being glued together as

well as secured by screws. The piece *a*, Fig. 2, extends entirely across the rear of the two supports forming a brace. A slot is provided in the upper end of each piece *b*, for the reception of the windlass shaft, a wire being run through a hole drilled just above it to keep it in place. Guides *c*, $\frac{1}{2}''$ square are also attached to the uprights to guide the board upon which the elements are mounted.









The shaft *d*, is made of a piece of 1″ round wood having a crank fastened to one end with handle. A ratchet wheel *e*, and a collar *f*, are also provided and fastened in such positions that they will guide the shaft and prevent its endwise movement. The ratchet should be made of some hard, tough wood, such as cherry, and secured to the shaft by glue and a pin inserted in a hole drilled through both ratchet and shaft, the collar being secured in the same manner. The pawl *g*, is fastened in such a position that it will properly engage with the teeth and hold the elements in any desired position in the solution. A rubber band stretched over two tacks, one on the pawl and the other on the support *b*, will keep it properly in place.

It is merely a matter of taste as to whether glass jars or a wooden box be provided to hold the electrolyte, but glass jars are expensive, easily broken, and if of the circular shape, hold less solution than a box of the form shown occupying a similar amount of space. On the other hand, the box will stand considerable rough usuage and will last for years. It should be made of well seasoned white pine, free from knots or cracks. After cutting the sides and bottom to the proper length, carefully mark off the positions of the cell divisions and cut transverse grooves $\frac{3}{8}''$ wide, and $\frac{1}{8}''$ deep, so that the dividing boards will fit in

very snugly. A part of the box is shown in detail at *h* and *k*. The end walls are also fitted into rabbets cut in the end of the boards. Make these joints as carefully as possible as no leaks must be allowed between the cells. The bottom is also rabbeted so that it will fit in between the sides and ends.

When these pieces are ready for assembling they are placed in an oven and heated to a temperature that is just comfortable to the hand. While heating melt about a pound of paraffin in a double water boiler, and have a brush in readiness. Now thoroughly coat the heated pieces with this melted paraffin, working it well into the grain with the brush, especially in the joints. Put the piece back in the oven and so treat another, repeating the process on each until it is well impregnated with the wax. The box may now be put together, making all the joints tight with screws, and after it is complete go over each joint several times with hot paraffin so that no possible chance of a leak may be present. The coating of paraffin is impervious to acids and the cell-box will last for years, but all solutions should be cold before being poured in.

The board upon which the cell elements are mounted is also paraffined to render it moisture proof and a good insulator. Fig. 3, gives the dimensions and general appearance after the connections have been made to the carbons and zincs. The carbons are 5″ x 7″ x ¼″ and secured to the strips *m*, by three brass screws, the wood battens having been boiled in paraffin to render them impervious to the creeping moisture from the cells. The holes for the screws must be drilled in the carbon plates with care, for while the carbon is hard, it is brittle and cracks easily. They may be drilled with either a small flat or twist drill, but should be large enough to easily admit the body of the screw so as not to split the plate.

The carbon plates of each cell are connected with each other by means of a thin copper strip about ⅜″ wide, bent so that it will pass down between the plate and the batten holding it, the middle screw passing through a hole in the strip. It will start back of the first plate, then passes over the block *m*, and down behind the middle plate when, it is bent back on itself passing over the next strip and back of the last plate, then after another flat bend passes up through a hole in the board and terminated with a binding screw. Before assembling, the copper strip should be thoroughly cleaned with emery paper until bright and the pressure of the screws will tend to keep a good contact, which at the best is difficult to preserve between carbon and a metal. The battens with the plates fastened to them are now screwed to the board so that they will occupy the centre of the cell intended for them.

By means of the brush apply melted paraffin to all the exposed portions of the mountings for fully an inch below the board, exercising care that it does not creep down between the plate and copper strip and especially covering the screw heads. This will do much towards preventing creeping salts from destroying the metallic connections and screws.

These carbons may be secured from electrical dealers at a nominal cost, but if the amateur wishes to make them he may do so in the following manner. Secure about twenty-five or thirty pounds of good hard coke (that coming from the gas retorts in a gas works is best) and grind in a mortar to a fine powder. Mix this powder with only sufficient tar to make stiff paste that will remain firm in whatever form it is moulded.

Make a strong box of smooth, hard wood, the inside dimensions of which are the same as those of the carbon to be moulded, one end being left open for the admission of the paste and stick to pack it in place. The lid or cover should either be fastened by screws or a clamp so that it may be easily removed to facilitate taking the finished plate out. It would also be well to have a thin ¼″ strip that forms the sides attached in such a manner that they may be easily removed.

Moisten the inside of the mould with water to prevent the tar from adhering and after introducing some of the paste, firmly pack it in by means of a flat stick and a small mallet, thus making the plate as dense as possible. When filled remove the cover and transfer the plate to a sheet iron box having a layer of charcoal or coke dust spread on the bottom. Thus make and pack eighteen plates in this box, putting a layer of dust between each so that they will not touch. After filling all spaces left in the box, lute the cover on with clay and place in a furnace and

heat to a cherry red for ten or twelve hours. This baking process cements the particles firmly together, reducing the tar to a solid carbon and rendering the plate very hard.

The zincs, being the only parts that need renewing, are soldered to posts made of No. 11 B. W. G. copper wire, provided with a thread and small nut at one end and a washer soldered on 1 ¾″ below the end to take the thrust of the nut. This nut may be made by threading a small copper washer. The zinc plate is 5″ x 5 ¾ x ⅛″ and should be cut from a rolled sheet to get the best material. They may be cast, but in this case, they are more apt to be porous and contain impurities that will cause considerable local action not available in the external circuit. Each plate is provided with two posts soldered on the edge as shown; these posts pass up through holes in the mounting board on one side; holes in a copper strip, serving also as a connector for the two plates. The small nuts are then screwed down tight and the copper strip provided with a binding screw, this method of securing the zincs rendering replacement very easy.

It is a good plan to amalgamate the zincs before assembling, as it considerably lengthens their life; scrub the plate thoroughly with diluted sulphuric acid (1 part acid to three parts water) and when bright pour a few drops of mercury on the surface and rub it around with the cotton swab until it spreads over the entire zinc.

The mounted elements are now suspended from the windlass shaft by two pieces of strong flexible picture wire, fastening the upper end a little out of a perpendicular line so that when the board is lifted a wire will wind out and then hang straight to the hooks. By raising or lowering the plates into the solution to various depths, the internal resistance is much changed, and the variable current is fed to the external circuit.

The illustration shows the cells connected in series, which increases the E. M. F. in proportion to the number of cells, but if they are connected in parallel (all zincs together and all carbons together) the total E. M. F. will be that of one cell but the internal resistance will be decreased in proportion to the number of cells, and consequently the output in current will be correspondingly increased.

The electrolyte is made as follows:

Potassium bichromate,	3 parts
Sulphuric acid,	4 parts
Water,	18 parts

Dissolve the potassium bichromate in the water, and then slowly add the acid while stirring vigorously with a strip of glass. This should be mixed in a stone jar, as the heat generated is sometimes sufficient to crack a glass vessel.

A LAWN SETTLE.

JOHM F. ADAMS.

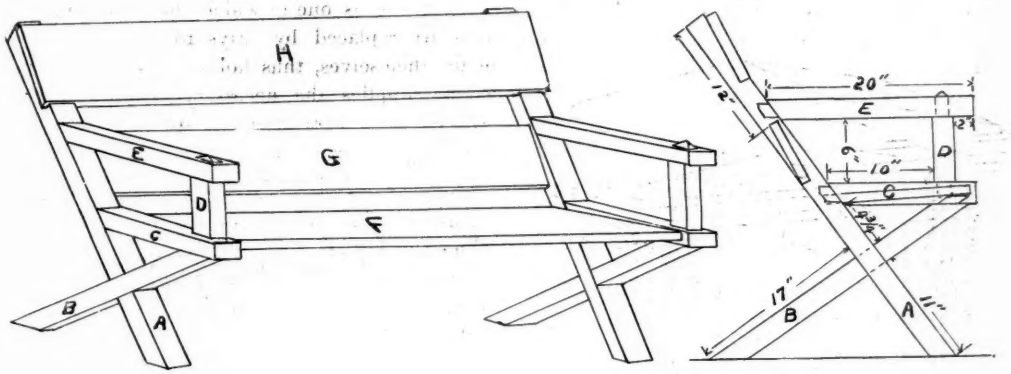
This is a settle for the piazza or lawn, and while more substancial than the cheaper grades of summer furniture, is not difficult or expensive to construct. Preferably it should be made of oak, and finished with a dark stain, but will be rather heavy for moving about much. A lighter one can be made of spruce or whitewood and stained as desired.

The ends are first made. The pieces *A*, are 40″ long and 2 ½″ square, and incline at an angle of 55° from the horizontal. The pieces *B*, are 29″ long, 2 ½″ square, and incline at 40°. These pieces are halved where they cross. At the upper ends of pieces *B*, cut tenons 2″ long, ¾″ wide, and ¾″ high, to fit mortises for same cut in pieces *C*. These pieces are 15 ½″ long, 2 ½″ wide, and 2″ thick, the tenons at the rear end being 2 ½″ long on the lower side, 3 ½″ high, and ¾″ thick. A mortise 1 ¼″ long, ¾″ wide, and 1″ deep, is cut at the front end for post *D*, and another on the inner side, 12″ long, 1″ wide, and deep for the seat *F*.

The post *D*, is 10″ long, and 2″ square, allowing for a tenon on the lower end 1 ¼″ x ¾″ x 1″, and on the upper end 2 ½″ x 1 ¼″ x ¼″, the end being beveled as shown. The arm is 20 ½″ long,

2 ½″ wide, and 2″ thick, the tenon on the rear end being 2″ long, on the lower side. The mortise at the front end for the post *D*, should be carefully cut to make a good joint.

A mortise 6″ long, 1″ wide, and deep for the back *G*, is also cut in the piece *A*, the upper end of



mortise being 12″ from the upper end. This mortise is cut at an angle with the piece *A*, the upper end not quite reaching the front side and the lower end not quite reaching the other side. The back *G*, is 43″ long, 6″ wide, and 1″ thick. The seat is 43″ long, 14″ wide, and 1″ thick. The rear corners are cut away, so that it may fit the mortises cut in *C*. The back *H*, is 48″ long, 8″ wide, and 1″ thick. Beveled grooves 2 ½″ wide, are cut 1″ from the ends, to fit pieces *A*, being nearly the full thickness of *H*, at the lower sides.

All joints should be set up with glue and fastened with dowel pins. Beef skewers may be used for the dowel pins. The lengths given for pieces *A* and *B*, allow for the lower ends being cut to the bevel as shown. Should the seat give too much under the weight of occupants, it may be supported by a strip 3″ wide in the centre, reducing to 2″ at the ends, which is fastened with strong screws to the centre of the under side of the seat. If the length of the settle is made longer, such a strip will be necessary. If the settle is to remain exposed to the weather, spar varnish should be used for finishing.

A MANTEL CLOCK.

GEORGE H. BABB.

The accompanying cut illustrates how a very pretty mantel clock can be made at small expense.

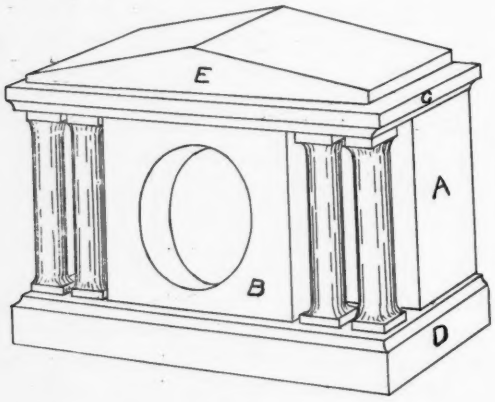
First, secure at any jewellers a small clock costing about a dollar, that you may know how large to make the opening in the frame. This opening for the accompanying dimensions should be about 2 $\frac{3}{16}$″ diameter.

The dimensions of the different parts when completed and assembled are, — Base *D*, ⅞″ x 3″ x 8 ⅜.″ Top *E*, ⅞″ thick in the middle, slanting to ¼″ at the ends x 2 $\frac{6}{16}$″ x 7 ½″. Face *B*, ⅞″ x 3″ x 3″. Part *A*, is made of three pieces mitered at the ends, the front piece of which is ⅝″ x 3″ x 7 ½″; the ends are ⅝″ x 3″ x 1 ⅝″ long. Part *C*, is ⅝″ x 3″ x 8 ⅜″. The moulding on *C* and *D* is made with a ⅜″ gouge and the mouldings laid out ¼″ on the faces.

The necessary lumber to construct the clock will be : — 1 piece of pine or whitewood, 1″ x 3 ¼″ x 20″, and 1 piece ¾″ x 3 ¼″ x 20″.

In constructing, it is best to cut from the piece 1″ thick enough to make the base *D*, and the face *B*, plane to dimensions. The remaining piece 1″ thick will be for the part *E*, and this will be

planed to dimensions. The next in order will be the pieces which form the part *A*. First plane one side and one edge true and square to each other, plane to thickness $\frac{5}{8}''$. Do not plane to exact width until the three pieces forming parts *A* and *B* have been glued and nailed together, and the glue has become thoroughly dry and hard. The part *B*, should be nailed from the back side of part *H*, a 16-1″ nail being driven and set at each corner.



Find the centre of face *B*, by drawing diagonal lines from the corners through this centre, bore a hole with a No. 4 gimlet bit so that the screw on the expansive bit used to bore the larger hole for clock opening will not split the face *B*. After the opening is made, a little cutting from the back with a chisel for the handle andlegs of the clock may be necessary. When this is done, the parts are ready to be glued and nailed together; the clock can then be painted. Be sure all nails are set, and the nail holes puttied after first coat. Three coats of inside white lead paint will be necessary. Sandpaper each lightly when dry with No. O, sandpaper. When well dried, paint with one coat of enamel paint. Or the lead paint may be dark, finishing with a coat of black enamel or ebony black to imitate black marble.

While the different coats of paint are drying, the pillars can be turned, or if no turning lathe is at hand $\frac{1}{2}''$ dowels may be used very satisfactorily. The capitals and bases are $\frac{9}{16}''$ square, and are $\frac{1}{4}''$ thick. The pillars are to be gilded. The pillars, capitals and bases should be glued together. The pillars should make a tight fit yet not so tight as to roughen the paint. They can be held in at the top by small nails, without heads, projecting downward from the piece *C*, into holes bored in the tops of the capitals, and No. 18 1 $\frac{1}{4}''$ nails driven up through the base into the bottoms of the bases.

One of the latest inventions in the line of storage batteries is one in which the jars commonly used are replaced by trays formed of the lead plates themselves, thus holding the battery fluid which supplies the necessary chemical actio n By this new arrangement, space, weight, and economy, as well as increased efficiency, are gained. The internal resistance is said to be low, and the battery may be charged or discharged rapidly, evenly or unevenly without injury, making it especially valuable for automobiles.

When the work now under way has been completed the power utilization of Niagara Falls will amount to something over 300,000 horse power, and the limit will not even then be reached. This is probably the greatest source of power in the world, but not the only one, for there are others almost equaling it, many of them in this country. When the conveying of the electric current long distances without loss is successfully accomplished, these natural sources of power development will be a great boon to the industrial world. In view of recent experiments in long distance transmission, the practical development of which seems fairly well assured, the time is not far distant when many of these great natural sources of power will be made use of.

A German engineer, Max Eberhardt, has been demonstrating a new preparation for the extinguishment of fires, which is reported to be very successful. It is in the form of a liquid, and articles painted or saturated with it become non-inflamable, it being found impossible to ignite them even after having been covered with tar or petroleum. A small quantity of the liquid will extinguish a fire that has gained headway. It is a cheap compound, and the experiments prove it to be one of the best fire-proofing and extinguishing agents yet produced.

ELEMENTARY SHOP PRACTICE.

FREDERICK W. TURNER, Rindge Manual Training School, Cambridge, Mass.

V. PINS AND REAMERS.

It would seem as if the operation of fastening two pieces of metal together by means of a pin was so simple that very little could be said about it. Such work is often done, however, in a manner that shows a crying need for some plain simple talk on the subject. The two general classes of this work are pinning flat plates and fastening two pieces to shafts.

Even such a simple operation as fastening two pieces of metal together with two pins admits of some consideration. Having decided on the size of the pins, a drill should be selected which will drill a hole which will be a tight fit for the pin. To make sure of this, it is a good plan to drill a hole in some old piece of the same metal as the

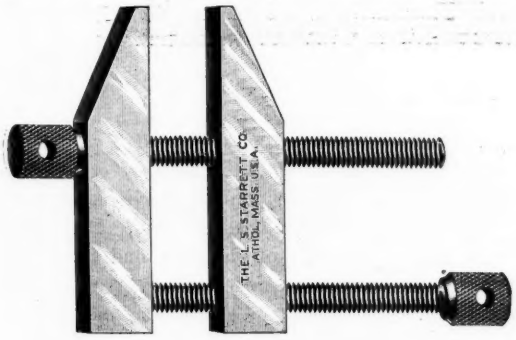


FIG. 37. MACHINIST'S CLAMPS.

plate. It is important that the metal should be the same, as different metals cause the drill to make different sized holes. Locate the holes on one piece only, preferably the smaller, and drill them through. After removing the burrs on both sides with a file, the pieces may be held together by any style of clamp, the machinist's clamp shown being as convenient as any. The piece already drilled now serves as a jig to locate the holes on the other piece, and the drill should be carefully fed through these holes to mark the lower plate. After marking to the full size of the drill, the upper plate should be removed and the holes drilled as located on the lower plate.

It is important that the holes should be marked to the full size of the drill, as the drill might run if it was not done, and it is equally important that the upper plate be removed before drilling the holes, as the passage of the chips through the holes has a tendency to enlarge them.

The burrs between the plates tend to keep the plates apart, and those on the outside prevent the formation of proper heads on the pins. They must be carefully removed. If the plates are ever to be taken apart, it is best to form heads on the pins which are entirely outside the plate so that one head may be filed off flush with the plate and the pin driven out. If, on the contrary, the plates are to be permanently fastened, each end of the hole should be countersunk to receive the head of the pin, and, after the pin has been upset to fill the countersink, the surplus stock can be filed off, leaving the head flush with the surface of the plate.

It is sometimes advisable to put in one pin temporarily before drilling the last part of the second hole, in order to insure that the holes will be accurately spaced. If more than two pins are needed, it is a good plan to put pins in the first two holes drilled, and these should have the maximum distance available. More than two steady-pins are unnecessary. The head of the pin should be first spread with the ball pene of a rivetting hammer and then finished with the face.

When a piece is to fastened to a round shaft, a pin is often used to make sure that the piece will not turn. If the hub of the wheel or other part fits a tapered place on the shaft, it can be tightened by driving up, but still a pin makes sure that it will not back off. If the shaft and hole are straight, it requires first-class workmanship to have the sizes just right to drive or shrink them into place. A pin is even more necessary in such cases. If a straight pin is used, implying a permanent job, the method is the same as out-

lined for pinning two plates, except that the pieces fit so tightly it is unnecessary to separate them and remove the burrs between. The pin may be headed on the outside of the hub, or driven into a countersink and filed off flush.

It often is very desirable, however, to take pieces apart after fastening, and to put them together again in exactly the same relative position. For this purpose the straight pin is not well adapted, as removing and replacing the pin wears the hole badly, and new pins must often be used on account of the battering the pin receives in driving out. It is obvious that a pin which is slightly tapered will not start from the hole of its own accord, and yet, if struck one sharp blow on the small end, it can be readily removed. The tapered pin, therefore, is used exclusively where taking down is essential. The amount of taper must be such that the pin will remain firmly in the hole and yet be easily removed when desired. Where the work is of a semi-permanent character, a taper of $\frac{1}{16}''$ per foot, commonly known as the locomotive taper, is employed. This draws up by a nut or drives in with a hammer so as to be practically a solid job. Such bolts and pins can be removed, however, but not by tapping with a hammer. When ease of removal is of more importance than solidity, a taper of $\frac{1}{4}''$ per foot, known as the pin taper, is better suited. In mentioning these tapers, the figures indicate the difference in diameter at points a foot apart. They indicate the included angle between the sides and not the angle between one side and the axis. In other words, it is a comparison of diameters and not of radii.

Our drills produce straight holes, so that it is necessary to use some other tool in order that the proper taper may be given to the hole before fitting the pin. These taper reamers, as they are called, are of several designs. The one best suited to very small articles, and especially to model or amateur work, is the jeweler's broach. This is a long, slender, tapering, five-sided reamer, a section of which is a pentagon. By using a drill about the size of the small end of the pin, the hole can be tapered by this reamer very quickly. It is used dry in cast iron, and in other metals moistened with oil. The pin can also be made by hand by holding the wire, which must be as large as the large end of the hole, in a hand or pin vise. By resting the wire in a notch in a wooden block held in a bench-vise or fastened to the bench, the vise and wire can be rotated back and forth by hand and filed to the proper taper. The fit of the taper pin can be tested by wiping the pin dry and clean, pushing it into the hole and giving it several twists; on removal, the points of contact will be indicated by bright spots on the pin. When tapered properly and brought to a size that just allows the pin to project through the hole, the small end may be rounded, the pin cut off at the large end and rounded

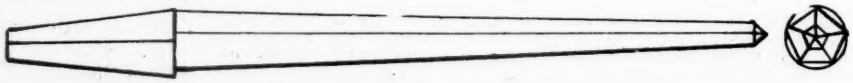


Fig. 38. Jeweller's Broach.

Fig. 39. Taper Pin Reamer.

Fig. 40. Locomotive Tarer Reamer.

up to such a length that the ends show equally. The difference in size between the ends is readily seen in pins $\frac{1}{2}''$ long and over.

For larger work, a fast cutting reamer to be used in a lathe or drill, may be made by tapering a piece of tool steel so that it looks like a taper pin with a straight shank. The tapered portion

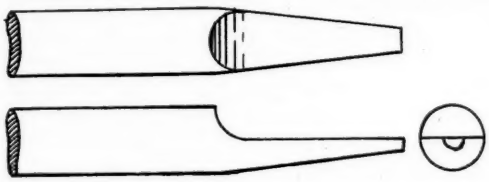


Fig. 41. Half Round Reamer

is then filed away on one side exactly to the axis, a section at any point being a semicircle. After hardening and tempering, it is ready for use. This style of reamer will make a very smooth hole, and, owing to the large space for the accum-

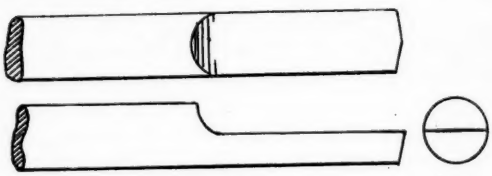


Fig. 42. Hog Nose Reamer

ulation of chips, will work quite rapidly. The taper is usually about $\frac{1}{4}''$ per foot. For still larger work of a commercial character, standard taper pin reamers, $\frac{1}{4}''$ per foot, are used. These are fluted and can be used either by hand or in a machine.

When short holes are reamed out tapering, the difference in diameter is so small that the amount of metal to be removed does not seem to be appreciable. In tapering long holes by means of a reamer, especially if the taper is steep, say $\frac{5}{8}''$ per foot, the amount of metal to be taken out becomes a serious proposition. Much time can be saved by using several sizes of drills first, drill clear through with the small drill, and then enlarge the hole to different depths with other drills, say three in number, making what is known as a stepped hole. As the drills remove metal by a cutting instead of a scraping action, the operation is more rapid. It is possible to conceive of a tapered hole being made by the use of a large number of drills of slightly varying size, each being entered to just the right depth. This would produce a tapered hole without the aid of a reamer.

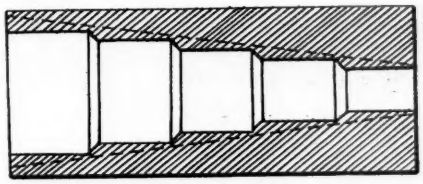


Fig. 43. Stepped Hole

The next method of holding to be considered will be that of bolting or screwing together. This involves making a spiral incline or helix on both bolt and hole, and is, therefore, more complicated than the straight or tapered pin. The shape of the helix is of great importance from the points of view of strength required and costs of manufacture. The distance between adjacent threads or, more commonly, the number of threads in an inch is called the pitch of the screw. This defination is not always accurate, as it applies only to screws of a single thread. A stricter interpretation would be the distance a bolt moves in its nut for each complete revolution, or the number of turns necessary to advance the screw one inch.

Fig. 44. Hand Vise.

There are in use in this country two general shapes and two modifications making four styles of thread. The two broad classes are the V and the square, the first having a section of an equilateral triangle, all sides equal and all angles 60°, and the second has a square

section, all sides equal and all angles right angles. Of course, the space between has same shape and dimensions as the threads themselves.

The modifications were brought about by troubles which were inherent in the V and square threads. The sharp outer point of the V was

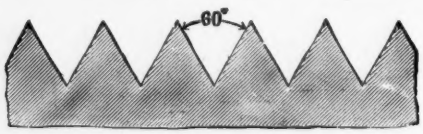


Fig. 41. V Thread.

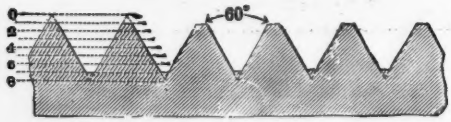


Fig. 42. United States Standard.

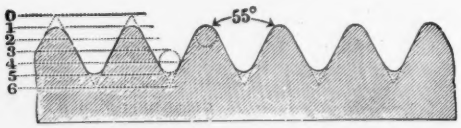


Fig. 43. Whitworth Standard.

liable to injury and had but little holding power, while the acute angle at the bottom of the thread tended to weaken the bolt. Both these troubles were minimized and the bolt strengthened when the Franklin Institute recommended and the the U. S. Govt. adopted what has since been known as the United States Standard thread. In this thread the top was flattened and the bottom filled up parallel to the axis by an amount equal to one-eighth of the pitch or side of the original V. This makes a stronger thread and bolt, but the old V thread is still much used on account of the ease of manufacture, the tool being simply ground to a point with an included angle of 60°

The square thread is extremely strong and has no tendency to split the nut under the heavy loads, but it renders necessary a tool of special shape which is hard to make and maintain. The modification, called the Acme thread, has the same sectional area, but the sides are inclined relatively to one another at an angle of 29°. This gives a slightly narrower top and broader base to the thread than the square type without sacrificing any of its strength, and allows the use of a tool which can be more easily maintained than that for the square form.

In addition to these four thread, mention should be made of the Whitworth or English standard. This is also a modified V, having an included angle of 55° with the top and bottom rounded by an amount equal to one-sixth of the pitch. This thread is stronger and less liable to injury than the U. S. standard, but is hard to generate. It is little used outside of England and her provinces.

PROJECTION.

Carl H. Clark.

VIII. CONES.

A cone is a solid having for its base a circle, and tapering to a point, called the apex. A line from the centre of the base through the apex is the axis, and when the axis is perpendicular to the base, the cone is a *right* cone; otherwise it is an oblique; the length $A\ B$, is called the slant height.

Fig. 1, Plate 26, is the plan and elevation of a right cone standing on its base; the apex is, of course, over the centre of the base.

Fig. 2, is the same cone, lying on its side with its axis parallel to the vertical plane; the elevation is of course similar to that of Fig. 1. To draw the plan, make the axis $C\ B$, parallel to the intersecting lines. As discribed in previous chapters, draw the semicircle $A'\ f\ g\ c$, and divide it into a number of equal parts $e\ f\ g\ h$; then draw the lines $e\ e\ f\ f$, etc., at right angles to $A'\ C$. From the points of intersection with $A'\ C$, drop perpendiculars passing through $C\ B$, in the points $e\ f\ g\ h$. Set off from these points on their proper perpendiculars, and on each side of the axis $C\ B$, the lengths $e\ e\ f\ f$, etc., from above and draw the

ellipse through the points obtained.

Project the apex from above to *B*, and from this point draw lines tangent to the ellipse representing the base and the plan is complete. As an exercise it is recommended that the student draw the elevation of this cone when the axis is turned through some angle with the vertical; which will be exactly similar to the method before followed.

Fig. 4, is the plan and elevation, after the axis has been rotated to 45° with the vertical, as has been several times described. The plan is a duplication of that of Fig. 3, at the required angle, and projection lines are carried across from Fig. 3, and up from the plane just drawn and the outline drawn through the proper intersections.

To develop the surface of the cone: — It is evident that, since all points of the base are equally distant from the apex, the surface of the cone will be a sector of a circle whose radius is equal to the slant height and whose arc is equal to the circumference of the base. The distance *A B*, is taken as the radius of a circle, and from some point a distance is laid off along the arc equal to the circumference of the base, and these two points connected with the apex or centre. The cone above discribed is three inches high and two inches diameter of base.

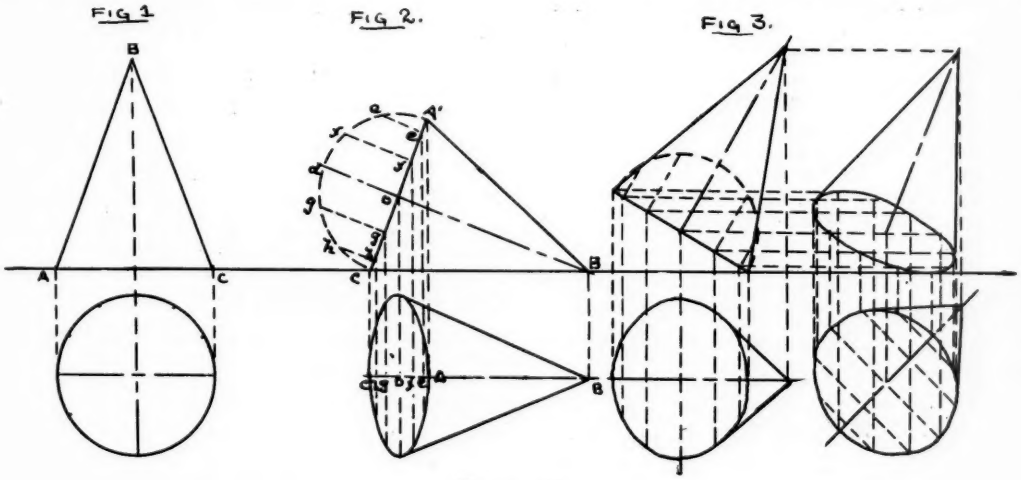


PLATE 26.

Fig. 3, is the elevation and plan of this cone when resting on one edge of the base, the plane of which is at 30° to the horizontal. It is plain that as long as the axis is parallel to the vertical plane the elevation will be the same as that of Fig. 1, differing only in angles, so that this elevation may be redrawn with its base at 30° to the horizontal. It is to be noticed that the base of this cone is represented by a straight line, this line is the edge elevation of a circle, so that a semicircle is drawn as before, which will represent one half of the base. Divide this semicircle and draw lines perpendicular to the base as before.

In the lower plane draw a line to represent the axis parallel to the intersecting line. From each of the points in the base of the cone, draw perpendiculars passing through this horizontal, and make them the same length on each side as the lines drawn from the points in the semicircle to the diameter. Through these points draw the ellipse which is the plan of the base; project the apex as before, and from this point draw tangents to the ellipse which completes the outline.

The section of a cone cut on any plane parallel to the base is evidently a circle. If it is cut on a plane oblique to the base, the section is an ellipse; the section on a plane parallel to the axis is a hyperbola, and on a plane parallel to one of the sides of the triangle, which forms its elevation, is a parabola.

The development of these sections is similar to that described under pyramids and the student who has made a careful study of previous lessons should have no difficulty in working them out.

AMATEUR WORK

63 KILBY ST., BOSTON

DRAPER PUBLISHING CO., PUBLISHERS.

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TO ADVERTISERS.

New advertisements, or changes, intended for a particular issue, should reach the office on or before the 15th of the previous month.

Entered at the Post-office, Boston, as second-class mail matter Jan. 14, 1902.

MAY 1903.

The delay in issuing the last few numbers of this magazine, is being reduced with the present one, and it is expected that soon the magazine will be ready on its regular publicrtion day.

The details of the grand prizes of an excursion to the St. Louis Fair in 1904, a screw cutting lathe, etc., cannot be announced as was expected, in this issue, owing to the inability to get final information about rates, etc., these not yet having been announced by the railroads. When this is received, the conditions for these prizes will be announced, but in the meantime, anyone contemplating working for a prize can do so, an account being kept in this office of subscriptions sent in by those competing for these prizes. One condition can be mentioned now, *i. e.*, no one making a regular business of soliciting subscriptions for magazines, will be eligable for a prize.

The large profits received from successful inventions serve as a stimulus to hundreds of people who dilegently seek to perfect some device which will direct the golden stream, or a part of it, into their pockets. In their haste to reach the reward quickly, many give too little thought to certain relative facts which have much to do with determining whether an invention be a success or failure. If an article to be manufactured and sold, an important question is: — Does a demand exist, or can it be created at reasonably cost, and to a sufficient extent to justify the outlay for testing the market.

Hundreds of inventions fail to meet this test; many being so imperfectly developed or so lacking in merit as not to warrant a trial. Yet the expense of securing a patent was assumed by some one, who may or may not have been able to suffer this loss without hardship. The patent office at Washington issues yearly thousands of patents, many of which are never heard of thereafter. While not wishing to discourage invention, we cannot too strongly impress upon inventors, the necessity of considering commercial as well as mechanical possibilities, and taking time enough to work out a meritorious idea so that the result will be well designed and constructed.

The Navy Department has been conducting experiments with crude oil as fuel for battleships, and with quite satisfactory results. These experiments may result in the adoption of this kind of fuel, although further tests will probably be made before this is done.

It is reported that the Machenzie-Pellatt-Nicholls syndicate will pay $15,000 a year for the privilege of developing electric power at Niagara with an additional fee per horse power, amounting in all to $80,000 per 125,000 horse power.

The discovery of large deposits of lithographic stone at Thessaly, Greece, are reported by Consul McGinley of Athens. The deposits are conveniently located for working and transportation, and the quality is reported to be far superior to any stone yet found in Europe. This is an important discovery and will be worked to advantage on account of its location and the facilities at hand.

WOOD TURNING FOR AMATEURS

F. W. Putnam, Instructor Manual Training School, Lowell, Mass.

VIII. FACE PLATE WORK.

A drawing for a bread board with the necessary dimensions for its construction is shown in Fig. 68. The largest diameter is 9″, so that this exercise may be turned on any lathe having a 10″ swing.

The bread board when finished may be fire etched; if this is done the board should be turned from basswood, otherwise maple or beech is to be used. From a board 1″ thick, cut out a circular piece 9 $\frac{3}{16}$″ in diameter; one side, which is to come against the face plate, being planed up true. Place the stock on the screw plate, Fig. 65, as described in the last chapter, and adjust the driving-belt for the slowest speed.

Place the rest so that the tee will be parallel with the face of the stock and slightly below the centre. The block is first to be "turned up„ with the 1″ or 1 $\frac{1}{2}$″ skew chisel, as shown in Fig. 66. The chisel is now to be used as a scraping tool. It is held in a horizontal position at about the centre-line. Fig. 66, shows the position of the skew chisel when the cut has been nearly finished. Care must be taken when the cut is completed at *A*, Fig. 66, that the wood does not splinter off on the back surface of the block. Because of this splintering it is sometimes advisable to finish the cut by placing the tee parallel with the shears, and using the gouge as was done in roughing down stock between centres. If desired, the truing up may all be done with the gouge as just described. The edge of the block is to be turned true in this way making the diameter exactly 9″.

The block is next to be "faced" and turned to the required thickness $\frac{7}{8}$″. Fig. 67 shows the front and top views of the position of the 1″ or 1 $\frac{1}{2}$″ skew chisel when used for this work. In rough turning, the gouge is generally used first, especially if the block does not run true. The gouge is held in the same manner as for the cylinder, lying on the centre of its back, but with the shaft considerably less sloped.

The cutting bevel is just on a line with the centre and the tool is frequently mounted in a short handle, both to avoid contact with the shears or tail stock and also to give the blade a little additional slope. This is sometimes an advantage, as it causes the tool to cut more freely.

The surface is first reduced by separate cuts, side by side, and then made flat by a continous cut from the edge to the centre, both hands moving with the gouge and keeping its shaft always parallel with itself. The fibrous surface left by the gouge is turned smooth with the skew chisel, which is held with its side lying flat on the tee. The chisel must be very sharp, its edge straight, and the bevel in good condition. The entire width of the cutting edge is not in contact with the work, one corner being held just free from it so as to prevent the corners catching in and spoiling the surface. For heavy work the cutting is generally done with the other angle. The chisel is to be advanced across the work in the direction of the corner having contact. For light work the obtruse angle is held just free from the block, the shaving being cut by the remainder of the edge and the acute angle.

Neither angle of the chisel is allowed beyond the centre of the surface, the cut commencing or ending at that point, always, by the extreme corner of the cutting edge. This surface is to be tested with a rule or straight edge, and any high places removed in the manner just described. The block may now be run at next the highest speed. Next make two pencil marks, one around the edge of the block $\frac{3}{8}$″ back of the front face, and the other to make a circle 7 $\frac{3}{4}$″ in diameter on the front face. With the skew chisel, held as shown in Fig. 66, cut a recess around the edge, just meeting the pencil lines previously drawn. The block will then have the form shown at *a*, Fig. 69.

On this recess $\frac{1}{8}$″ back from the edge, mark a circle; this will be 8 $\frac{3}{4}$″ in diameter. Around the edge mark a line $\frac{1}{4}$″ from the back face of the block, and with the skew chisel, held as before, reduce the block by cutting a second recess, the

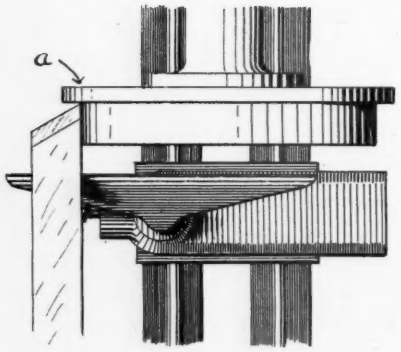


Fig. 66 – Top View.

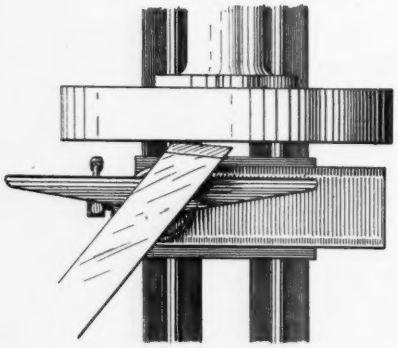


Fig 67 – Top View.

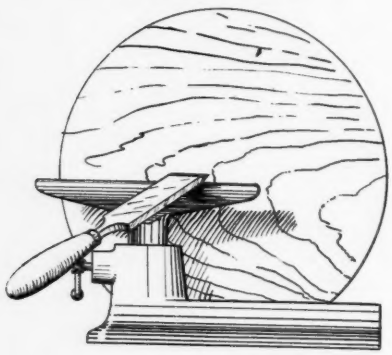


Fig 67 – Front View.

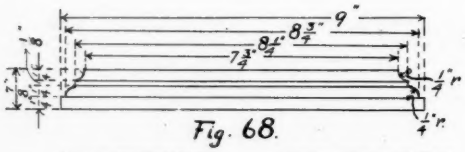


Fig. 68.

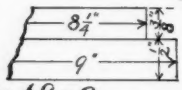


Fig. 69 – a.

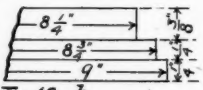


Fig. 69 – b.

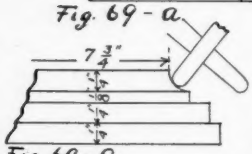


Fig. 69 – c.

Fig. 69 – d.

Fig. 70

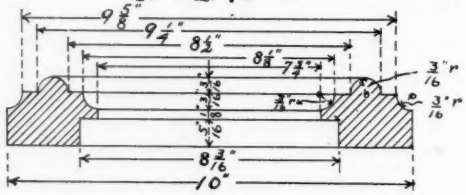


Fig. 71.

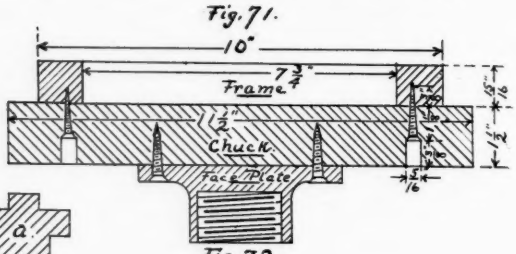
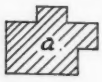


Fig. 72.



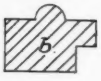


Fig. 74.

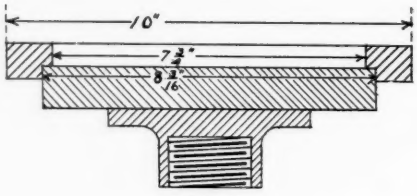


Fig. 73.

block now taking the form at *b*, Fig. 69. Next form the quarter hollow with the round nose. This tool was shown at *d*, Fig. 10. This is distinctly a scraping tool and must be held as shown at *c*, Fig. 69, the cutting edge being exactly on a line with the centre of the work. This concave curve is a quarter circle of $\frac{1}{4}''$ radius, so there will be left a $\frac{1}{8}''$ fillet as shown in *d*, 69. Finally with the $\frac{1}{4}''$ skew chisel, held flat as a scraping tool, round the corner to form the quarter round bead as shown in *d*, Fig. 69.

The bread board is now to be sandpapered. Care must be taken in sandpapering, not to make the curves or fillets blunt. For this exercise use No. O, sandpaper. Sometimes the top surface will show many very fine concentric rings which have been cut into the surface by the sandpaper. If the block is to be varnished and polished, these rings must be removed, I have generally found that the simplest way was to remove the face plate from the lathe, and placing the sandpaper on a block, carefully sandpaper with the grain until the marks had disappeared. The use of varnish, etc., for finishing turned work will be discussed in a later chapter. Fig. 70, shows four other forms, either one of which may be used for the edge of the bread board if desired.

A Picture Frame or Mirror Frame.

Fig. 71, is a cross section drawing of a picture frame or mirror frame. This may be made from quartered oak, or can be "built up" of thin pieces of black walnut and maple or gumwood and pine. If the latter method is followed, the pieces should be of the same thickness, being planed perfectly true on both sides, and the pieces before being fastened together should be "glued sized." To glue size boards, apply a liberal coat of glue to each surface and allow the glue to dry a little before rubbing off the glue. This coat should have filled up the pores in the wood to such an extent that, when a second coat of glue is applied, the glue will be held firmly between the surfaces of the boards. To prevent a "built up" frame from warping it is advisable to place the alternate pieces the opposite way of the grain. The boards when prepared in this way should be tightly clamped together and left to become perfectly dry before being turned. The front part of the frame may be turned on a screw plate, if desired, in the same way as the bread board. A recess or rabbet must be turned in the back of the frame for the glass, so that a "chuck" in which the frame can be fastened must also be used.

Chucking.

Pieces like the frame, spheres and rings, generally require turning over their entire surface, consequently for a position of the work they must be held and supported in some other way than the face plate or screw plate. Usually a "chuck" is used, consisting of a separate piece of wood fastened to the face plate by screws as shown in Fig. 72. This chuck, which is generally made of pine; has in the centre of the front face a cavity of such size and shape that the article to be finished may be forced into and held firmly by the chuck. The two should fit so that only a very moderate amount of effort will be necessary to force the stock into the chuck, the chief requirement being that there be friction enough to hold the block securely while the turning tool is held against it. One chuck with only a little refitting will often serve for chucking several blocks.

There are several methods that may be followed in turning up the mirror frame, two of the most common being given below. The first method is shown in Fig. 72. A pine block, cut to 11 $\frac{1}{2}''$ diameter, and 1 $\frac{1}{2}''$ thick, is fastened by four 1" No. 8, screws to a face plate. First true up the edge of the block, and then the front face exactly the same as in the turning of the bread board, running the lathe at its slowest speed. The 1 $\frac{1}{2}''$ skew chisel which is to be used for this, must be kept very sharp and the edge perfectly straight.

Next remove the face plate from the lathe, and mark on the back side of the block a circle 8 $\frac{7}{8}''$ in diameter, and on the front face a circle 10 $\frac{1}{4}''$ in diameter. The block out of which the frame is to be turned is then laid on the pine block with the planed side down, and clamped tightly to the pine block by four clamps. The frame is to be fastened to the pine block by four 1 $\frac{1}{2}''$ No. 10 screws. These screws are to go into the frame $\frac{3}{8}''$ so that holes must be bored in the pine block from the back side so as to countersink the heads of the screws $\frac{3}{8}''$. To do this, bore four holes at 90° apart along the 8 $\frac{7}{8}''$ circle with a $\frac{5}{16}''$ auger bit, boring the holes $\frac{3}{8}''$ deep. Follow these holes through the pine block with a $\frac{1}{8}''$ gimlet bit (No.

4.) This gimlet bit may be used to just start holes in the frame if desired. These holes should not be over $\frac{3}{16}$″ deep as the screws only go into the frame $\frac{3}{8}$″. The screws are then put in and tightened. The clamps may now be removed, and the face plate, pine block and frame returned to the lathe.

The hole cut out of the frame is 7 $\frac{3}{4}$″ in diameter, and the diameter of the frame when finished is 10″. It will be seen then that the 8 $\frac{1}{8}$″ circle was necessary, so as to put the screws into the middle of the rim of the frame. The stock for the frame is cut out 10 $\frac{3}{16}$″ diameter so a 10 $\frac{1}{4}$″ circle was necessary on the front face of the pine block in order to easily place the frame centrally on this block. Run the lathe at its slowest speed, and, having marked out a circle 7 $\frac{1}{2}$″ in diameter on the front face of the frame, cut through the frame along this line with the parting tool. The cut must be taken a little at a time. and the tool quickly withdrawn, otherwise the temper may be drawn from the edges.

Next true up the edges, reducing the diameter to exactly 10″ and through the hole to exactly 7 $\frac{3}{4}$″ in diameter. True up the front face, leaving the frame $\frac{13}{16}$″ in thickness. The front face is now to be marked out and turned down, following through the various steps shown at *a*, *b*, *c*, Fig. 74. The half bead is to be scraped round with the $\frac{1}{4}$″ skew chisel, and the quarter hollow turned out with the $\frac{1}{4}$″ round nose chisel exactly the same as in the case of the bread board. Carefully sandpaper the frame with No. O sandpaper.

If the frame is made of oak, or any coarse grained wood, it should next be filled, two coats of filler being used. The use of fillers etc., for finishing turned work will be taken up in a later chapter. The frame is now to be removed from the pine back by taking out the screws. Next cut in the pine back, which now becomes a "chuck", a recess in which the frame is to be placed, the back of the frame being exposed for the turning of the rabbet which must be cut out for the glass. This recess will be the same diameter as the frame, 10″. The rabbet may be started with the parting tool or small gouge, but had best be finished with the $\frac{3}{8}$″ skew chisel. This rabbet is to be $\frac{5}{16}$″ deep and 8 $\frac{3}{16}$″ in diameter. The glass is cut 8 $\frac{1}{8}$″ in diameter, and so should fit loosely in the rabbet, so that if there were any shrinkage of the frame, it would not split by coming up against the edge of the glass.

The second method of turning the mirror frame is shown in Fig. 73. The block for the frame is first fastened to a face plate, turned up, and the rabbet cut in the front face. The frame is then removed from the face plate and a pine block or chuck, 8 $\frac{3}{8}$″ in diameter, and $\frac{7}{8}$″ thick is substituted. This chuck is to be trued up to a very little more than 8 $\frac{3}{16}$″ diameter, so that the frame, which has had a rabbet 8 $\frac{3}{16}$″ in diameter cut out of it, can be forced on to the chuck. Fig. 73, shows the frame fastened to the chucks, trued up and the hole 7 $\frac{3}{4}$″ in diameter cut out The front of the frame is then finished up as in the first method.

Comparison of the Two Methods.

The second method does not require so large a chuck, can be turned on a smaller lathe than is necessary in the first method, and should not take so long in turning, providing the frame can be held by the chuck during the turning up of the front face without the frames "running out" of true. The objection is that often times the frame is left only partly finished; until the following day, when it may be found that the frame no longer fits in the chuck tight enough.

The first method requires a larger chuck and also a lathe with a 12″ swing, but affords a better opportunity of turning up the front face, as the frame is securely fastened to the chuck, and cannot "fly out" of the chuck, if a tool happens to get caught in the revolving block. This method, it seems to me, is preferable for the turning of large, heavy frames requiring considerable scraping to reduce them to the proper shape.

A report from Victoria, B. C., is to the effect that valuable coal and petroleum lands have been discovered in Southeast Kootenai, only a few miles from a branch of the Canadian Pacific railroad. Several hundred miles of territory have been staked off in claims. This is an important and valuable discovery, and considerable interest is being manifested. The claims will no doubt prove valuable to those who have secured them.

A 1=4 H. P. HORIZONTAL ENGINE.

B. R. Wicks.

IV. PISTON SLIDE VALVE.

The two piston packing rings, No. 359, are to be bored out, turned and cut off. Chuck this casting and bore out the inside diameter to 1 13-32″ diameter, and turn the outside diameter to 1 17-32″. Make this cut smooth and free from tool marks. With a narrow parting tool cut off the rings so that they will fit the 1-8″ grooves cut in the piston. They must not bind on the edges, but be a good working fit. Remove all the burrs made by the parting tool with a V pointed scraper. Now cut out a piece 3-64 of an inch wide, at an angle of 45°, and file the two ends smooth. This is to allow the rings to be sprung into the grooves in the piston, and also stopping the steam from leaking past the piston. It would be well to make three of these rings in case one should break in springing it into the grooves.

The piston slide valve, No. 364, is held by one of the ends and centered with the centering tool. A No. 10 twist drill is used to drill the hole the entire length of the casting. Before removing it from the chuck, run the tail-stock in this hole to steady the castings while roughing it out to within 3-64″ all over the figures given in the detail. The end that has been held in the chuck while the drilling and roughing was being done should now be turned around, end for end, and also be roughed.

To finish the piston slide valve, make a mandrel to fit the No. 10 hole, and also long enough so that a small lathe dog may be used in the ends. Finish up between centres, face the total length to 25-16″. The two ends must be exactly 3-16″ wide, and the steam space 1 15-26″ between the two ends. The smallest diameter of the valve is 3-8″. This can also be turned to size. The two ends must now be turned to fit the valve chest, so in drawing it back and forth it will be air tight, yet slide freely. This fit can be made by taking very light cut, using the reamer used to ream out the valve chest chamber and a pair of micrometer calipers to get your size. It would be well to set your calipers a trifle larger than the reamer, and very carefully finish to fit the bore with a fine cut file.

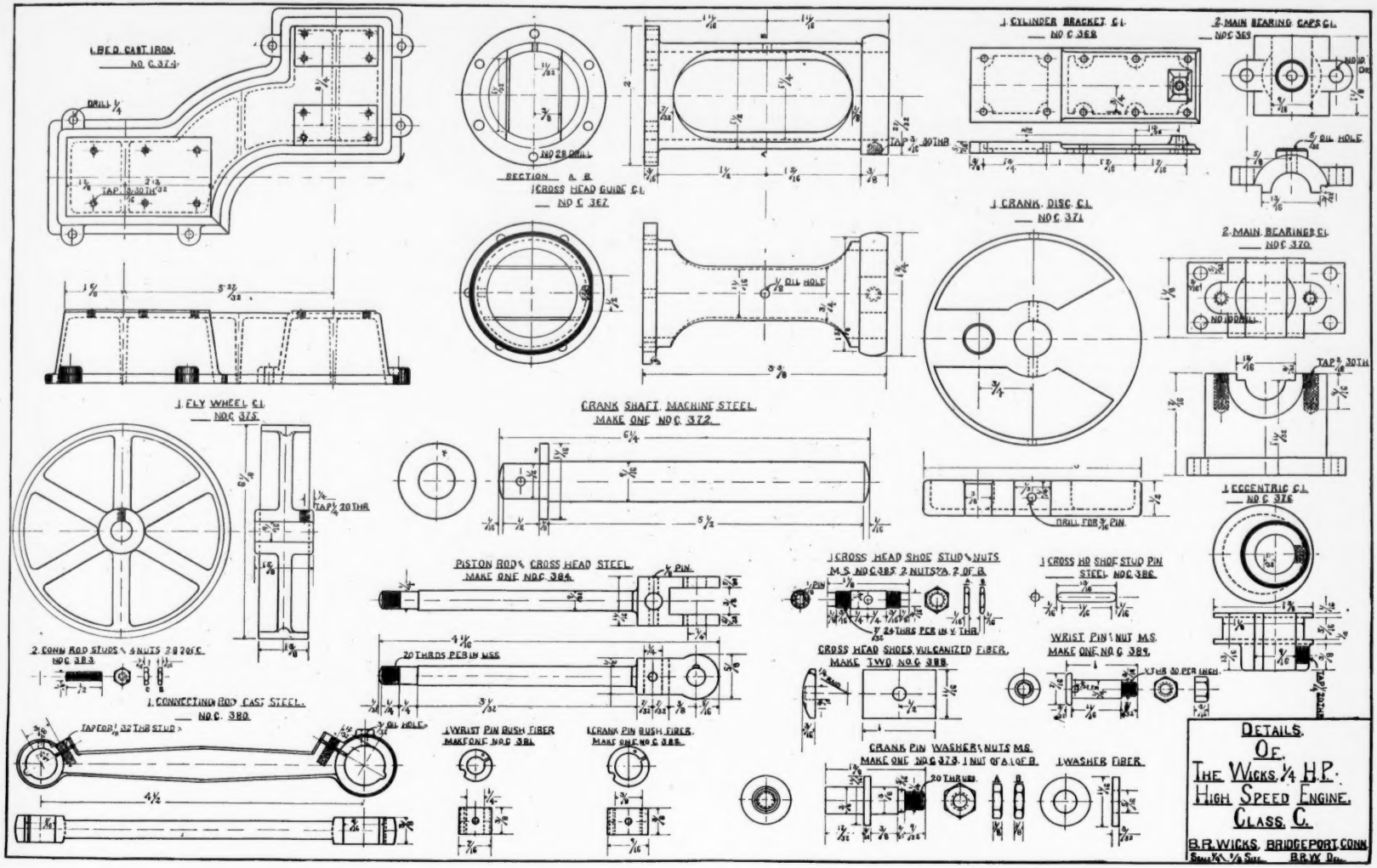
The two sides and the slot for the connecting rod to work in, can be milled to a very good advantage. This milling operation can be done in any lathe by holding the casting by the long round part that is to form the piston rod proper, in the tool post of the slide rest, and using an end mill of ample diameter to cover the surface of the sides in place of the usual lathe centre. The hole for the wrist pin is also drilled at the same sitting, so that the drilling will be absolutely true with the slot for the connecting rod and sides, which is a very important feature.

But before taking the milling operation in hand the casting will have to be turned between centres 3-4″ larger than 9-32″ which is to be the finish size. The part of this casting that is to form the cross head has a cored slot in it, and as the casting is going to be turned between centres, this slot must be stopped up in order to get some solid foundation for a centre. So start the work by filing out the rough surface left from the core, and force in this slot a piece of sheet brass or cast iron to form the foundation. Also see that the long round end is perfectly straight. Place the casting on a pair of small V blocks, letting the cross head hang over, and by the aid of a scratch block or surface gauge, find the centres of each end. If after getting the centre on the round end and trying it on the lathe, the slotted end does not come central, take notice of which side it is out, and strike the head of the casting with a hammer until it shows central. Center with a small centre drill and slightly countersink both ends.

Place the casting between centres and turn the long part that is to form the piston rod to 3-64 larger than the size of 9-32 given on detail drawing, No. 384. This cut must be smooth and true, and is to be taken the full length until it reaches the round filet where the cross head begins. The casting can now be removed from between centres, and the brass piece carefully driven out, so as not to spring the casting. File off the scale on the left side of the casting, and apply a little blue vitrol.

Replace the casting on the two V blocks, and with a scratch or surface gage, find out the exact centre of the turning. Set the side that has been rubbed with vitrol square with the surface plate on which the two V blocks set. Strike a line on the side of the cross head; this will give the horizontal centre of the hole for the wrist pin. To find the vertical centre, set a pair of dividers to make a 11-16″ circle, this being the diameter of the round of the cross head in the rough, which will be finished later to 5-8″. Make a light puck punch mark where the lines cross indicating the centres, and set a pair of dividers to make a 1″ circle; on this circle make guide marks to tell which way to chip it if it does not come central.

The casting can now be placed in the tool post of the slide rest, holding it in position in the tool post by the end that has just been turned, taking care that the end that is to form the cross head proper is far enough out of the tool post to mill the full length of the sides,


1 BED. CAST IRON.
NO C 374.
DRILL 1/4
TAP 3/8 30TH
1 CROSS HEAD GUIDE C.I.
NO C 367
NO 28 DRILL
SECTION A B
1 CYLINDER BRACKET C.I.
NO C 368
2 MAIN BEARING CAPS C.I.
NO C 369
NO 10 DRILL
5/64 OIL HOLE
1 CRANK DISC C.I.
NO C 371
1/8 OIL HOLE
2 MAIN BEARINGS C.I.
NO C 370
NO 10 DRILL
TAP 3/8 30TH
1 FLY WHEEL C.I.
NO C 375
TAP 1/4 20 THR
CRANK SHAFT MACHINE STEEL.
MAKE ONE NO C 372.
DRILL FOR 3/16 PIN.
1 ECCENTRIC C.I.
NO C 376
PISTON ROD & CROSS HEAD STEEL.
MAKE ONE NO C 384.
1/8 PIN.
20 THRDS PER IN MSS.
1 CROSS HEAD SHOE STUD & NUTS
M.S. NO C 385. 2 NUTS "A" 2 OF B.
1/8 PIN
1/4 24 THRS PER IN V THR.
1 CROSS HD SHOE STUD PIN
STEEL NO C 386
2 CONN ROD STUDS & 4 NUTS 2 B 2 O F C.
NO C 383.
CROSS HEAD SHOES VULCANIZED FIBER.
MAKE TWO NO C 388.
WRIST PIN & NUT M.S.
MAKE ONE NO C 389.
1/4 THR 30 PER INCH.
1 CONNECTING ROD CAST STEEL.
NO C 380.
TAP FOR 1/8 32 THR STUD
3/64 OIL HOLE
4 1/2
1 WRIST PIN BUSH FIBER
MAKE ONE NO C 391
1 CRANK PIN BUSH FIBER.
MAKE ONE NO C 392.
CRANK PIN WASHER & NUTS M.S.
MAKE ONE NO C 373. 1 NUT OF A. 1 OF B.
20 THR MSS.
1 WASHER FIBER.
DETAILS
OF
THE WICKS 1/4 H.P.
HIGH SPEED ENGINE.
CLASS C.
B.R. WICKS. BRIDGEPORT CONN.
SCALE FULL 1/8 SIZE.
B.R.W. DR.

so as not to leave any marks when completed.

Before commencing the drilling and milling operation, the casting will have to be set central with the 1-4″ circle for the wrist pin, and the turning with the lathe face plate. After putting the casting in the tool post and fastening down, see how the prick bunch mark and the lathe centre line. If they do not, the casting can be tapped up or down until it is correctly located. The turning must now be set parallel with the face plate. This is done with a pair of inside calipers. Try the turning on each end until the calipers show that the distance is the same on each end with the face plate.

It would ensure a better job, to have a pair of V blocks to set in the tool post, of about 2″ long, to hold the casting in place. Then there will be less danger in springing the turning when securing down in position. If these V blocks are not at hand a couple of pieces of cold drawn steel, that will fit the slot in the tool post, will answer; one on the top and one on the bottom. These V blocks or steel pieces will not come close together so there will be no trouble in setting the casting lengthways with the inside calipers.

When the castings is ready, drill the hole for the wrist pin, No. 386. Put a small centering tool in the chuck and enlarge the puck punch mark so that a 15-64″ twist drill will start true, and drill through the casting, feeding slowly and using lard oil. This finishes the hole for the wrist pin, with the exception of reaming it out to 1-4″ with a 1-4″ hand reamer. Now the 3-8″ slot to receive the connecting rod is to be milled. A milling cutter 2″ diameter and 3-16″ wide will do the job in good shape. This mill can be held between centres on a mandrel, provided with washers, and held in position by a nut on the end. Start and divide up the stock on each side of the inside of the cored slot in the casting, and feed in the mill very slowly using plenty of lard oil.

HOW TO BUILD AN AUTOMOBILE.

WILLIAM M. FRANCIS.

III. THE REAR AXLE.

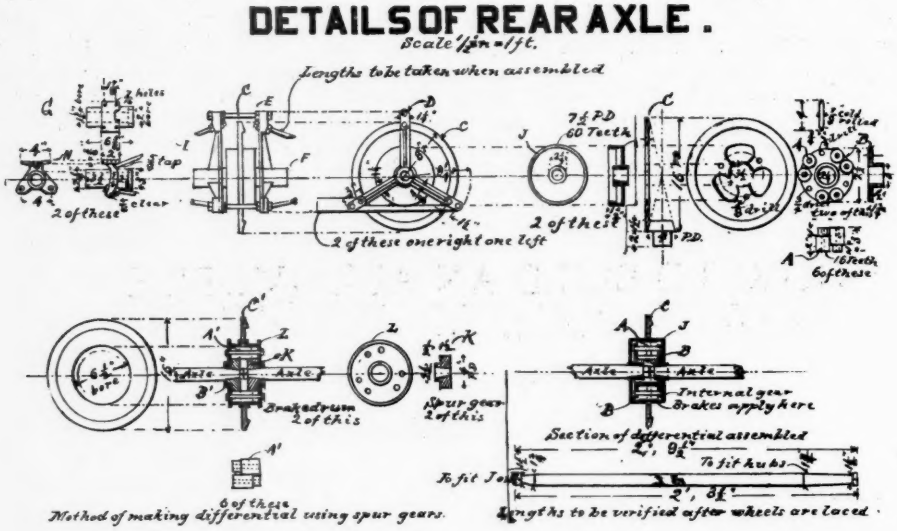
In order that a carriage may be driven by the rear wheels, leaving the front ones free for steering, it is necessary to provide some means by which one wheel may either run a little faster or slower than the other on account of irregularities in the road, or when turning a corner. For instance, if the inner wheel was describing a 20′ circle and the carriage had 4′ tread, the outer wheel would be describing a 28′ circle, or the inner wheel would go 62. 8′ while the outer one would go 87. 9′ or 25. 1° farther. Without the differential either one or the other of the wheels would have to slip this difference in their travel. Some carriages have an indispendent motor for each rear wheel but nearly all use a single drive to the rear axle, through a differential gear.

The one here specified is to be preferred on account of the gears being cased in, as well as the fact that there is no wide thrust on the gears to spread them apart, which bevel gears have a tendency to do, and last but not least, the brake is applied directly to the drums of the differential which are keyed to the halves of the axle. When applying the brake therefore, power is not transmitted through the small pinions and teeth, with the consequent liability of breaking the latter were power applied too suddenly. This style of gear may be bought ready to put on the axles and owing to the high price of cut gears and the time consumed in fitting, it will be adviseable to purchase the differential. A servicable differential can be made by using stock cut gears for the two larger gears and having the long pinions cut to order, as shown in the drawing at *A*, Fig. This however brakes through the pinions and teeth. The side pieces *B*, are cut of cast-iron. A pattern for this will have to be made, allowing enough stock on the outside to turn down for the brake, also some bosses to face off where the pinions come. These may then, in finishing, either be faced up in the lathe or with a counter-boring tool. In drilling the holes for the pins of the small gears, it is well to slip one of the large gears in place, and then clamp the pinions in their relative positions, using these as a guide to start the point of the drill. It will be found almost impossible to lay out the holes, drill them, and have the six pinions rest properly without having to file some of the holes or teeth. The cheek pieces, it will be seen in Fig. form the bearing for the large gears, as well as for the bevel gear. The bevel gear, is a cast gear with the arms left out and sufficient web cast in to bore and face to fit the cheek pieces. A gear moulding machine makes a pretty accurate gear, but it will be found necessary to do some filing on the teeth.

The yoke pieces shown at *D*, which form a support for the trusses and a bearing for the axle next to the differential, are steel castings brushed, or Tobin bronze, which saves the expense of brushing, the cost per pound being about the same. These are bored running fit on the axle and faced, leaving a small projection over the hub of the differential to keep from working down into the joint. A circle is struck for the truss holes while the piece is in the lathe, and the

outer hole bosses can also be faced. The inner holes can be faced more conveniently with a counterbore after the holes are drilled. It will be noticed that there is a slight difference in the angle of these holes on account of one part of the axle being longer than the other. The distance pieces *E*, which hold the yokes apart, are either, steel castings or forgings turned to fit the holes with the shoulders faced.

ter, if time will permit, to take a piece of rough machinery steel large enough to turn to the proper size, and draw the ends down to nearly the size to turn the taper. This condenses the metal and increases the tensile strength, and when cutting the thread in the lathe, it is not so liable to run out. Owing to the construction here given, it is necessary to have the axle turned all over, if not of cold rolled steel, so that it may be



One end of the hubs of each yoke is bored at *F*, to fit a piece of steel tube to be brazed in. The other end of the tube is similarly fitted to the outer bearing which is shown at *G*. This bearing may be of steel casting or Tobin bronze. If steel, it will have to be bushed. As shown, the casting has a tableture *H*, cast on it to receive the bottom part of one of the rear springs. The truss rods go through the lugs, the top one being tapped in, and the bottom ones slide through with a lock nut on each side of the lug. The truss rods *I*, are rough, rounded steel.

The axles may be made out of cold-rolled steel turned down to fit the differential gears on one end, and the hubs of the wheels on the other; both gears and hubs have to be keyed on. It is found that these fits are better tapered, with the key let into the axle and caulked in. In other words, a feather key. In case of having to take it apart, the taper fit is easier to get off than a straight one. While cold rolled steel makes a very good axle, if it is not turned but used as it is brought, it is found that if the outer skin is removed by turning, the steel is of a softer nature and the nearer you get to the centre the more spongy it gets. Also, it will be found that, after every chip if much is taken off, the piece will run out of true. It is therefore better, if time will permit, to take a piece of rough machinery steel large enough to turn to the proper size, and draw the ends down to nearly the size to turn the taper. This condenses the metal and increases the tensile strength, and when cutting the thread in the lathe, it is not so liable to run out. Owing to the construction here given, it is necessary to have the axle turned all over, if not of cold rolled steel, so that it may be slipped through the outer bearing or the outer bearing may be bored a trifle larger than the yoke.

In reply to an inquiry relative to the advisability of investments in agricultural lands in Cuba, Consul R. E. Holaday, of Santiago de Cuba writes:

Considerable quantities of land have already been bought by citizens of the United States. Persons desiring to buy land should either make a personal investigation or be represented by some competent person, as there is much undesirable and unproductive land on the market. The soil of Cuba is adapted to the production of coffee, sugar, cacao, tobacco, corn, potatoes, vegetables, and tropical fruits of all varieties, but there are large areas that are nonarable. Coffee and cacao are raised principally in the mountainous regions. The cacao is cultivated in connection with the coffee plant, as the latter requires shade, which is furnished by the former, at the same time yielding a profitable crop. Cacao can also be profitably grown in the lower and richer districts. The rich river valleys and plains are devoted to the cultivation of sugar cane.

PIN-HOLE PHOTOGRAPHY.

NEGATIVES MADE WITHOUT A LENSE.

This branch of photographic work does not seem to have received the consideration, from amateurs, to which its possibilities entitle it.

Those who are interested in securing artistic views will find pin hole photography quite interesting, and also what often is of decided importance, requiring but a very moderate expenditure. The writer was first attracted to it through a desire to secure a larger print than could be taken on the one camera, (4 x 5), which he possessed, and was not equipped to make enlargements. There are undoubtedly many others similarly situated, who would be interested to learn of this kind of work to make a beginning.

A few observations as to what it is, and is not, will more clearly show the field of its usefulness. In general it is quite like work with a lense, but as the light admitting apperture is much smaller, a much longer time of exposure is required; this varying with the size of the pin hole, and the distance between the hole and the plate. The sharp definition obtained with a lense is also lacking, but this is rather an advantage than otherwise, as the foliage and other landscape effects secured by this process are considered to be one of its chief merits. Views of buildings will show absolutely correct lines, the distortion sometimes met with lenses being absent. The angles of view are wide, enabling subjects to be taken possible only with wide angle linses of extreme capacity, the latter not generally being included in the amateur's outfit.

The following description is an outfit for views (10″ x 12″) larger than many may require, but will serve to show how any desired size can be made. A plate holder is the first requisite. This, for the size mentioned measures outside 11 1-2″ x 14″. A box is carefully made of whitewood measuring inside, 15″ long, 14″ wide, and 11 1-2″ high. The front end is left entirely open. On one side at the back, a door is made 3″ wide, two small brass hinges being fitted on the outside. Another door is made in the centre of the back for focusing and view finding, the hinges being on the lower side and a button at the top for fastening.

A frame of narrow strips is made to fit across the inside of the box, the back edge being flush with the jam of the door. This frame also is an exact fit to the plate-holder, so that no light can enter the box from the door when the plate holder is in position and a plate being exposed. An examination of a focusing camera will show what is necessary. Two additional strips are also fastened across the door, one to the top and the other at the bottom, with short lengths of spring to each strip, which hold the plate-holder rigid and yet allow it to be easily removed.

Another box is made with one open end, closely fitting the front end of the first box. The sides of the second box are only 3″ long, the grain of the wood of this box being across that of the first one. The open end is on the inside. In the centre of the closed end a hole 1″ diameter is bored. Around this hole, on the outer side, fit a 2″ frame of three sides made of 3-8″ wood, on the inner edges of which a 1-8″ rabbet has been cut to receive the pin-hole diaphragms. Another diaphragm should also be made with a 1-8″ hole to be used in focusing, as the smaller holes admit so little light as to make it a difficult matter to focus with them.

The diaphragms may be made of tin-type metal, several being needed. Cut out squares to fit the frame, leaving a 1-2″ lug on one side of each, which is bent over to facilitate removal. With fine emery cloth, polish the centre of each square, and also reduce the thickness somewhat. Place the square on a smooth, level piece of wood, hold a steel, sewing needle over the centre and gently tap with a small hammer. This causes the needle to act as a drill, and a hole will soon be formed. The holes should vary in size, one each for Nos. 6, 8 and 10 needles. Before the hole has reached the full size, take off the burr formed on the under side of the plate with emery cloth, so that little or no burr is formed when bringing the hole to full size. In this way the edges of the hole will not be ragged, a quite necessary feature. Other sizes of holes can be made as experience is gained and occasion requires.

The inside of the boxes should be painted a dull, deep black and sockets for tripod screw fitted on the bottom and the side without the door.

The box holding the diaphragm is placed in the open end of the larger box. After focusing, the plate holder is placed in position, the slide drawn and the plate exposed. To determine the necessary length of exposure will require some experience, but the following table will serve as a guide for general estimates.

EXPOSURE IN MINUTES

Distance from Plate to Hole	Size of Hole No. 6	No. 8	No. 10
6 Inches	2	4	6
8 ,,	4 1 2	7	10
10 ,,	8	11	15
12 ,,	12	16	22

The position of the movable diaphragm box is regulated by the composition of the view. The nearer the front it is, the smaller the field included on the plate, and the larger the negative obtainable. Very rapid plates should be used for the longer exposures, the

size of the hole being determined by the degree of light and the definition. Orthochromatic plates are also very desirable on some views, interesting experiments being a prominent feature of this work. Readers are recommended to give it a trial, with the belief that they will find much pleasure in so doing.

CORRESPONDENCE.

OUR readers are invited to contribute to this department, but no responsibility is assumed for the opinions expressed in these communications.

Letters for this department should be addressed to editor of AMATEUR WORK, 63 Kilby Street, Boston.

They should be plainly written on only one side of the paper, with a top margin of one inch and side margins of one-half inch.

The name and address of the writer must be given, but will not be used, if so requested.

Enclose stamps, if direct answer is desired.

In referring to other letters, give the number of the letter referred to, and the date published.

Illustrate the subject when possible by a drawing or photograph with dimensions.

Readers who desire to purchase articles not advertised in our columns will be furnished the addresses of dealers or manufacturers, if stamp is enclosed with request.

(41.) W. BRATTLEBORO, VT., APR. 25, 03.

I take advantage of your correspondence department to ask a few questions about making an induction coil. I find the magazine very instructive and can think of no where else to ask what I want to know about. I am constructing a wireless telegraph, and a good coil is needed in order to get the desired results. I have decided to make my own coil, and desire to know the windings, etc., of a coil to give a 4 or 5″ spark, and also for one 10″. Will be very grateful for any information you can give.

F. W. R.

The costs of materials for coils the sizes you mention will be consideral, about one pound of silk covered magnet wire, No. 36, being necessary in the secondary for each inch of spark. This is a general statement for approximating cost. As this wire costs between $3.00 and $4.00 per pound, it is possible you may not care to undertake to make one on this account. In the June, 1902, number of this magazine will be found directions for making a coil, which if well made, will give a spark over 1″ long, and operate for a mile or more under favorable conditions.

Direction for making a large coil will be given if after receiving this information, you still desire them.

(No. 42.) SPRINGFIELD, VT., APR. 23, 03.

I wish to make a spark coil to give a spark from 1-4 to 1-2″. Would I be able to get a spark of this size from a coil 5″ long, and 2″ in diameter, wound with No. 36 wire in the secondary? Which would give me the best results, No. 18, 22, or 24 wire for primary? Would it make the spark any larger or smaller if I wound two layers of No. 22 or 24 wire on the outside of the coil to finish out with? How many layers will I need for primary coil?

T. G. L.

The following are the dimensions for two coils.

ONE HALF INCH SPARK.

Length of Core 6″ x 1-2″
Length of Bobbin 5″
Primary 2 layers No. 18 C. C. M. W.
Secondary 3-4 lb. No. 36 S. C. M. W.
Condenser 40 sheets 4 x 5
Battery 2 cells

ONE QUARTER INCH SPARK

Length of Core 4″ x 1-2″
Length of Bobbin 3 1-2″
Primary 2 layers No. 18 C. C. M. W.
Secondary 6 ounces No. 36 S. C. M. W.
Condenser 30 sheets 3 x 4
Battery 1 cell

You will note that No. 18, wire is specified for the primary. The two outer layers of larger wire on the secondary are of no value; rather the reverse.

(43.) WORCESTER, MASS., APR. 24, 1903.

I have a boiler under construction to run a 1 H. P. Steam Engine. It is made by running 1 1-4″ iron pipe vertically into a chamber which holds most of the steam, water being inside the pipes exposed to the heat. The pipes are 30 in number and 14″ long, I wish to use a kerosene burner of the type described in the November, 1902. number of this magazine. The boiler is 14″ diameter. Will the gasifiers give sufficient heat to keep up steam at 100 lbs. pressure? If this kind were used, would it be advisable to use larger pipe in connecting the pin valves? I enclose a rough drawing of cross section of boiler.

G. O. R. Jr.

The design of the boiler for which you send drawings (not shown) is not correct, as it provides no circulation of the water; consequently the water would be carried out of the pipes by the steam. It will be advisable for you to learn more about the construction of boilers, this type being known as the Field boiler. Each vertical tube should have a smaller tube inside of it, the latter having both ends open, and the upper ends of both tubes below the water level. The steam as fast as generated would rise in the space between the two tubes; the cooler water decending through tne inner tube, thus securing free circulation.

The type of kerosene burner mentioned would not be suitable nor economical for such a boiler, A burner of the kind used in automobiles would be much better to use, as such burners can be seen in about every locality, no description is here given but will be if requested.

JUNIOR DEPARTMENT

For the Instruction and Information of Younger Readers.

A NECKTIE ELECTRIC LIGHT.

HARLEY WHEELER.

This pleasing novelty is designed to be used at night, is a source of great attraction, being quite brilliant, and very interesting to make. A chloride of silver battery, suitable for this light was described in the November, 1902, number of this magazine. Four cells are to be used, and a wooden or brass box must be made to hold them. If of brass, a plate 6″ square, and No. 18 guage will be necessary for the complete box.

Cut out a piece of brass 5 3-4″ x 2″. Lay out as shown in Fig. 1, bending at the lines *A*, *B*, *C*, *D*, so as to form a rectangular box, and then solder it together at the open corner. Next cut an outer piece, 2 1-4″ x 5-8″ for the bottom, and solder in place. Smooth off all sharp edges with a file and emery cloth. Cut another piece the same size as the last, and bore holes as in Fig. 2. This piece is to hold the cells of the battery in place. The 1-8″ holes are for the wires connecting the cells, which comes from the pieces of silver in the centre of each cell. The 1-8″ holes on one edge are for the wires attached to the zincs. Be sure and insulate well with wax paper between each of the cells and the box. The last mentioned piece of brass, is placed down on the cells, with the connecting wires projecting through the holes, and then soldered at the corners to the box. A wooden box can be made of thin, cigar box wood in about the same way.

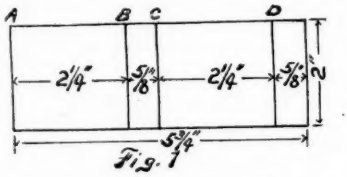


Fig. 1

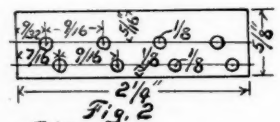


Fig. 2

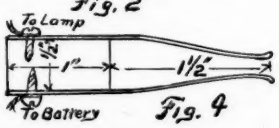


Fig. 4

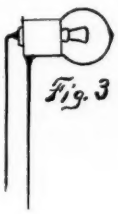


Fig. 3

Fig. 5

Connect the cells in series, *i e*, the silver of one to the zinc of the next and so on. Cut out a piece of wood to just fit in the top of the box, and deep enough to just touch the top of the connecting wires, first drilling two 1-8″ holes in one end for the terminal connecting wires. These wires should be flexible, the kind used for electric drop lights will answer, with a dark colored covering. Anyone who may not find it convenient to make a battery can purchase one for about 40 cents; the kind used in night lamps is suitable and will easily go in a side coat pocket. Be sure that the voltage of lamp and battery are the same however, a battery with too a high voltage will burn out the lamp, and too low will give but a dim light.

The globe is the next thing required. It should be the smallest size obtained, 1-2 to 1 candle power, 2 1-2 or 3 volts and may be obtained at any electrical supply house. Get a piece of stiff brass wire, 2 1-2″ long, and No. 15 guage for a pin. Grind it to a tapering point, and solder it at right angles to the base of the lamp as shown in Fig. 3. It should be filed and dressed off smooth with emery cloth to make it look well. A similar piece of wire, 2″ long, and pointed, with a right angle bend 3-8″ from the blunt end, is soldered to the brass terminal in the centre of the base of the lamp as shown. Very large pins, if obtainable, can be used, thus avoiding the trouble of making them. Do not let the brass rim get connected with the centre terminal by solder or the lamp will be short circuited.

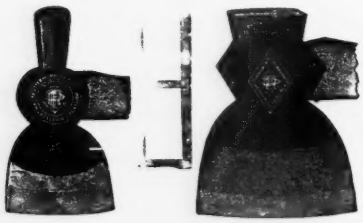
Cut the flexible wire cord already mentioned, into two pieces 2′ long, and solder one end of each piece to connecting brasses to be described. Connect the other end of one cord, by putting it through one of the holes in the block of wood, with the zinc post of battery. The silver post of battery is connected with one side of the contact block, by a short piece of flexible wire cord. To the other side of contact block, connect the end of the other long wire cord.

The contact block is next made. Cut out a piece of hard wood 1″ x 1-2″ x 5-8″. Cut two pieces of spring brass 2 1-2″ x 5-8″, and after boring holes in one end for short screws, bend the outer ends as shown in Fig. 4. This block is carried in the pocket along with the battery,

Tne two contact brasses, Fig. 5, are made of thin pieces of brass 3-4″ x 3-8″. V shapes grooves are bent across the short diameter, and holes drilled through the V ridges to fit the pins on the lamp. The pieces are soldered to the ends of the cord as previously mentioned.

To operate the lamp, the pins are put through a dark neck tie or coat, in such a way that the two pins do not touch. A brass contact piece is placed on each pin, the connecting wire being carried under the vest or lappel of coat to the pocket containing battery, and contact block. By bringing the bent ends of this block in contact with each other, by pressing with the fingers, the circuit is completed and the lamp lighted. A bent piece of brass which will just fit the bent ends, may be used to keep the light continious. but this should not be very long at a time or the battery will run down. The contact pieces may be covered with rubber bands if they touch, so as to prevent short circuiting.

TOOLS AND THEIR USES.



HATCHET. AXE.

AXES. This tool is in such common use as to be familiar to all. A medium size hatchet will be found more useful, the shape known as a "shingling hatchet" being the best for all-round work.

BACK SAW See *Saws.*

BELL HINGES GIMLET See *Gimlet.*

HAND BELLOWS. FOOT BELLOWS.

BELLOWS. The hand bellows is used by moulders for removing dust and surplus facing powder from moulds for casting metals.

The foot bellows is very convenient for giving a continous and steady supply of air to blow-pipes used for brazing and soldering.

BELT PUNCH. See *Punches.*

BENCH BLOCKS. Bunch blocks are heavy masses of cast iron or steel, used for shaping and truing metal work. One face is frequently planed flat and true, the others having a series of half holes of varying sizes and shapes, for convenience in working or bending round or square wire, rods, etc. They are also known as *Swage Blocks.*

BENCH SCREW. BENCH STOP.

BENCH SCREWS are used for making bench vises. They are made of both wood and iron. The threaded nut on the rear end is attached to the inner side of the side board of the bench, anabling the screw to be turned in or out as desired. A diameter of 1″ for iron and 2″ for wood, make convenient sizes for amateurs; and as they cost but little and are very useful, should form a part of every tool outfit.

BENCA STOP. For planing and other operations requiring the work to be held rigid, a bench stop is very desirable. Stout screws or blocks of wood of various shapes are often used, the former being likely to cause nicks in tools, unless care is taken. The iron stop here illustrated is quickly adjustable to height, is strong and well worth the small sum asked for it.

HANDY RECEIPTS.

WATERPROOF GLUE.

Dissolve 1 part of best glue, pulverized, in 1 part of thick linseed oil varnish which should be boiling hot when glue powder is added. Mix thoroughly until glue is all dissolved. Both the wood and glue should be warm when the glue is applied.

RUBBER CEMENT.

A very good rubber cement can be easily made by cutting 1 ounce of fine Para Rubber into small pieces and putting them into a wide mouthed bottle and the covering then with either corham bisulphate. The bottle should then be tightly corked and allowed to stand for one day. Then put in more of the liquid, and so on, until a thick fluid is obtained. This makes about a pint of cement.

POLISHING WAX FOR FURNITURE.

Put 4 ounces of white wax in an earthen vessel and pour over it 3 ounces of oil of turpentine. Cover the vessel with a piece of strong paper and heat over a slow fire in a water bath until the wax is melted. When the mixture cools it will assume a whitish color. Before it gets too hard, mix with it about 2 ounces of pure, strong alcohol.

AN EXCELLENT WRITING INK.

A very fine writing ink is made of gall nuts, 11 parts; sulphate of iron, 2 parts; solution of indigo, 1-7 part; water 33 parts.

TRADE NOTES

The new catalogue of the L. S. Starrett, Company, Athol, Mass., just received has as a frontespiece, a very fine half tone illustration of the new plant, recently completed, and said to be the largest in the world devoted exclusively to the manufacture of small tools for mechanics.

The catalogue contains 176 pages, and there is something on every page to interest the lover of good tools. It is no exaggeration to say that these tools are the finest that scientific accuracy and mechanical skill can produce. There are quite a number of new tools represented, which will be highly appreciated by mechanics, both as time savers and assistants in producing the most accurate work. This company is certainly a progressive one and in the front rank as manufacturers of fine mechinists' tools. They will be pleased to mail this new catalogue to anyone interested upon request.

Frank S. Tucker, manufacturer of telephones at No. 1 Hartford St. Boston, advises that he has about fifty transmitters which he is offering, at the very low price of 50 cents each., postage paid. This is a fine opportunity, for amateurs who are making a telephone outfit.

The Ohio Electric Works, Cleveland, Ohio, has placed on the market a line of efficient Battery Fan Motors, for either wet or dry batteries. The sizes are from 5 to 12″ fans. The Motor with 9″ fan takes only 3-4 of an ampere at volts and runs the fan at 1600 r. p. m. A new catalogue with discount sheet is now ready for mailing.

The "Yankee" Tools made by the North Bros. Mfg. Co., Philadelphia, Pa., are all that could be desired in the way of convenience and also of workmanship. Several of them; the automatic drill, No. 40; ratchet screw drivers, Nos. 11 and 15, are to be added to the premium list, but anyone desiring can obtain them at once.

The Disston Saw is so well known the world over as to require no special mention, other than to say that the user of any of the tools made by Henry Disston & Sons, Philadelphia, Pa., is a satisfied worker. Amateurs who are getting an equipment of tools, will make no mistakes in purchasing the Disston tools.

Labor saving is the phrase that applies to Campbell's Varnish Stain, made by Carpenter Morton Co., 77 Sudbury St., Boston. They stain and varnish with one application and produce a fine imitation of the different hard woods.

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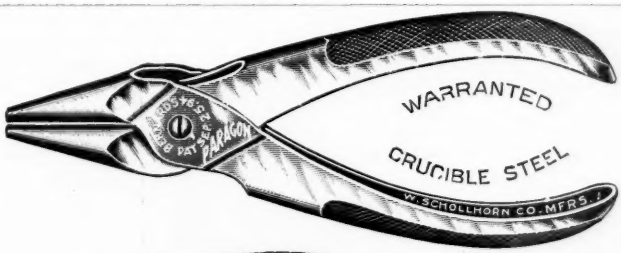

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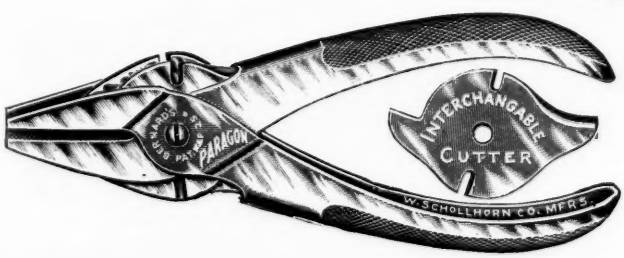

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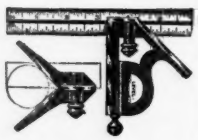

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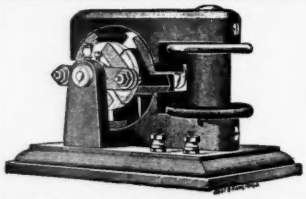

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